

TIMBER CONNECTORS
DESIGN and LOAD DATA

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**MANUAL OF TIMBER CONNECTOR
CONSTRUCTION**

TIMBER ENGINEERING COMPANY
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TIMBER CONNECTORS—USES—TYPES

TECO connectors for timber construction are devices used in timber joints which give a high degree of efficiency to the connections and make possible the utilization of a higher proportion of the strength of the member outside the joint than is possible with most other types of fastenings.

Timber joint connectors were introduced into America by the National Committee on Wood Utilization of the U. S. Department of Commerce. Since then connectors have been widely used for many types of construction. Improvements in certain types and the development of new types of connectors have been accomplished so that the

diversified requirements for connectors in timber construction are now quite completely met.

Timber joint connectors of several types have been extensively tested by the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture at Madison, Wisconsin.

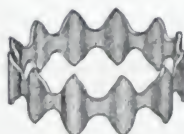
The designs and technical information presented in the following pages were prepared by J. E. Myer of the Timber Engineering Company, from the test data of the Forest Products Laboratory and from conferences with members of its staff, particularly John A. Newlin and J. A. Scholten, of the Division of Timber Mechanics. Acknowledgment is also made to various university and private laboratories.

TYPES OF TECO TIMBER CONNECTORS



SPLIT-RING

Manufactured from low carbon steel: Used between two timber faces for heavy construction and fits into pre-cut grooves in the timber faces. The tongue and groove "split" permits simultaneous ring bearing against the core wall and outer wall of the groove into which the ring is placed. The inside bevel and mill edge facilitates installation into and removal from its groove.



TOOTHED-RING

Manufactured from low carbon steel: Used between two timber faces for comparatively light construction and embedded into the contact faces of the joint members by means of pressure.



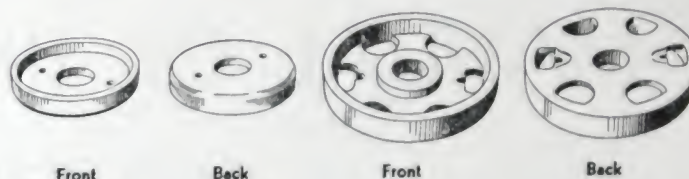
Male



Female

CLAW-PLATES

Malleable iron connectors: Used as "units" either in pairs for timber-to-timber connections or singly in making timber-to-metal connections. The female plates are adapted to use when the connector must lie flush with the surface of the timber. Claw-plates are installed by forcing the teeth into the wood beyond the depth of the circular dap cut to receive the rim and plate portions.



Front

Back

Front

Back

Pressed-Steel

Malleable Iron

SHEAR-PLATES

These plates when installed lie flush with the timber surface. They are used as "units" in pairs for timber-to-timber joints with two plates placed back to back, or singly in timber-to-metal joints with the plate placed with its back toward the metal. The plates fit into pre-cut grooves in the timber faces.



Flat



Single Curve



Double Curve

SPIKE-GRIDS

Manufactured from malleable cast iron: Used primarily in pier and trestle construction between either flat or curved surfaces. They are embedded into the wood surfaces by means of pressure.



Plain



Flanged

CLAMPING-PLATES

Stamped from metal sheets: Used as railroad "tie spacers" between ties and guard timbers to keep the ties properly spaced, or where timbers overlap at right angles. The plain clamping plate with teeth on opposite faces is seated by means of a special block which protects the connector during the driving process. The flanged clamping-plate with teeth on one face only is driven into place with a maul or ram, the connector being protected from damage by a steel cover plate.

TIMBER CONNECTORS—FACTORS INFLUENCING ALLOWABLE LOADS

The allowable safe working loads for timber connectors presented in the tables are for standard use conditions.

STANDARD DESIGN LOADS

Standard Design Loads apply to most of the loading conditions under which all types of TECO connectors are used, where the dead loads are less than the live loads, and where the full live loads are applied for relatively short periods of time. They are 115 per cent of the basic values which were derived from test data by applying appropriate factors. For those connectors, namely, split-rings, claw-plates and shear-plates, which exhibited an initial straight line load-deformation ratio and a proportional limit, a factor either of 4.0 on maximum test loads or 1.8 on proportional limit loads was applied; the lower result being the basic value taken. Where the characteristics of test curves for connectors lacked a definite straight line load-deformation ratio, and where the proportional limit was not clearly indicated, such as for the toothed-rings, spike-grids and clamping-plates, a factor of 4.5 was applied to the maximum load. These factors are more conservative than those generally applied in foreign countries where connectors were developed and widely used. The basic values as determined above allow for a permanently applied full load, a condition not usually encountered in the use of timber connectors.

PERMISSIBLE LOAD INCREASES

Wood is able to support loads of short-time duration such as caused by wind, earthquake and impact, greatly in excess of permanently applied loads, hence appropriate increases in connector loads are allowed depending on whether the failure at ultimate joint load is of the wood, or a combination of wood and metal, or of the metal. Recommended load increases are given in the notes accompanying the table for each connector. Increases in connector loads in excess of those customarily allowed for wind and earthquake are justifiable for those types of structures where life hazard is not involved, where property damage would be slight in case of failure, where the ability to stay exactly in place is not important or where infrequent replacements are more economical than the expense involved in more conservative design.

LUMBER THICKNESS

Tabulated loads apply to connectors when used with lumber of the net thickness specified in the tables. The use of connectors in lumber thinner than the minimum given in the tables is not recommended.

CONDITION OF LUMBER

Tabulated loads apply to connectors used in lumber seasoned to approximately 15 per cent moisture content within 1/2" of the surface, which is the condition it will eventually reach in most parts of the United States. When installed in green or wet material which will remain wet a reduction in the tabulated loads is required. Where conditions are such that the lumber in which the connectors are installed will become seasoned to 15 per cent moisture content within a reasonable period of time, the full rated loads may be used with those connectors which fit into pre-cut grooves or daps; and reduced loads, depending on

the moisture content, must be used with those connectors which are installed by being pressed into the wood. Notes for each connector give the degree of load reduction necessary.

LOADS FOR OTHER SPECIES

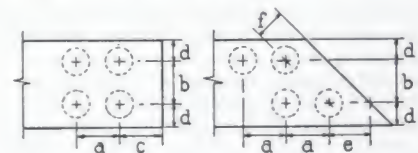
Loads for species not listed may be estimated by a comparison of their mechanical properties with those of the listed species or may be obtained on request from the Timber Engineering Company.

WORKING STRESSES FOR LUMBER AND TIMBER

For working stresses of lumber see Wood Structural Design Data, Supplement No. 1.

LOADS IN RELATION TO DISTANCES AND SPACINGS

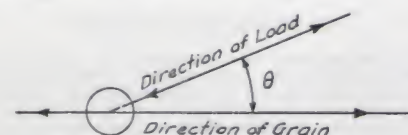
Standard Design Loads are for standard end and edge distances and spacings. Standard distances and minimum distances with load reduction factors are given in the tables accompanying the load tables. Loads for distances intermediate of standard and minimum are obtained by interpolation. These spacings and distances apply unless assemblies for specific use are tested and the results justify their modification. Distances and spacings of connectors are measured as shown in the accompanying diagrams.



- a. Connector spacing parallel to grain
- b. Connector spacing perpendicular to grain
- c. End distance
- d. Edge distance
- e. Maintain end distance as minimum
- f. Maintain edge distance

LOADS AT ANGLE TO GRAIN

In general load capacities of connectors decrease as the angle of load to grain increases. The method of measuring angle of load to grain is shown by the following diagram.



The angle θ used in determining the allowable loads on connectors, spacings between connectors, and edge and end distances, is that formed by the direction of grain in the member and the direction of the load transmitted to the member by the connector. When loads are axial in the members this angle is equal to the angle of intersection of the two members joined by the connector. When loads other than axial are superimposed on a member the direction of the resultant of all loads in the member is the direction of load used in determining angle to grain.

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TIMBER CONNECTORS—SPLIT-RING DESIGN DATA

SPLIT-RING , Order Number	1	2	3
(All dimensions in inches)			
Inside diameter at center when closed	2-1/2	4	6
Thickness of metal			
Center . . . . .	.163	.193	.245
Edge . . . . .	.143	.173	.245
Depth	3/4	1	1-1/4
Inside diameter of groove for ring installation	2.56	4.08	6.12
Width of groove . . . . .	.18	.21	.27
Depth of groove . . . . .	.37	.50	.62
Shipping weight, per 100 rings, lbs.	30	76	196
LUMBER DIMENSIONS , minimum required for installation of rings			
Face width	3-5/8	5-1/2	7-1/2
Thickness, rings in one face only	1	1	1-5/8
Thickness, rings of same size, placed opposite in both faces	1-5/8	1-5/8	2
Thickness, with rings of different size, placed opposite in both faces	Use minimum for largest ring		
BOLT , diameter, minimum	1/2	3/4	3/4
Diameter, with rings of different size, placed opposite in both faces	Use minimum for largest ring		
BOLT HOLE , maximum diameter in timber	9/16	13/16	13/16
WASHERS , Standard			
Round, cast or malleable iron, diameter	2-1/8	3	3
Round, wrought iron (Minimum for use in simple structures)			
Diameter	1-3/8	2	
Thickness	3/32	5/32	
Square plate			
Length of side	2	3	3
Thickness	1/8	3/16	1/4
SPACING OF SPLIT-RINGS , center to center			
0°-30° angle of load to grain			
Spacing parallel to grain, standard, for full allowable load	6-3/4	9	12
Spacing parallel to grain, intermediate, reduce loads 25% except for one ring	5	6-7/8	9-1/2
Spacing parallel to grain, minimum, reduce loads 50% except for one ring	3-3/8	4-7/8	7
Spacing perpendicular to grain, standard and minimum	3-1/2	5-1/2	7-1/2
30°-90° angle of load to grain			
Spacing parallel to grain, standard and minimum	3-1/2	5-1/2	7-1/2
Spacing perpendicular to grain, standard	4-1/2	6-1/2	8-1/2
Spacing perpendicular to grain, minimum, reduce loads 15%	3-1/2	5-1/2	7-1/2
END DISTANCES , center of ring to end of piece			
Tension members, standard, for full allowable load	5-1/2	7	9
Tension members, minimum, reduce load 37.5%	2-3/4	3-1/2	4-1/2
With cross bolt between ring and end of piece, full load may be used with distances of	4	5-1/2	7-1/2
Compression members, standard	4	5-1/2	7-1/2
Compression members, minimum, reduce load 37.5%	2-1/2	3-1/4	4-1/4
EDGE DISTANCES , center of ring to edge of piece			
0°-30° angle of load to grain, standard and minimum	1-3/4	2-3/4	3-3/4
30°-90° angle of load to grain, standard, on compression side of ring	2-3/4	3-3/4	4-3/4
Minimum distance, reduce load 15%	1-3/4	2-3/4	3-3/4
30°-90° angle of load to grain, standard and minimum, opposite compression side of ring	1-3/4	2-3/4	3-3/4
PROJECTED AREA for portion of one ring within a member, square inches	1.10	2.25	4.16

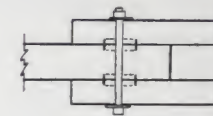


SPLIT-RING



SINGLE SPLIT-RING JOINT ASSEMBLY

Split-ring in one face of each member



MULTIPLE SPLIT-RING JOINT ASSEMBLIES

Split-rings opposite in both faces of middle members; in one face of side members

(Single bolt and more than one ring)



MULTIPLE SPLIT-RING JOINT ASSEMBLY

Split-rings in one face of each member

(More than one bolt with split-ring on each bolt)

SPLIT-RING SPECIFICATIONS

Split-rings shall be manufactured from hot rolled, low carbon steel conforming to A.S.T.M. Standard Specifications for carbon steel A 17-29, Type A, Grade 1. Each ring shall form a closed true circle with an outside cylindrical surface parallel to the axis of the ring. The inside surface, except for split-ring No. 3, shall be beveled from the median line toward the edges. It shall be cut through in one place in its circumference to form a tongue and slot. Split-rings shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to split-rings used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface or in green lumber which will reach this condition in the structure within a reasonable period of time. If used in green lumber which will stay wet, use 67 per cent of the tabulated loads.

TIMBER CONNECTORS—SPLIT-RINGS—SAFE LOADS

SINGLE SPLIT-RING LOADS

The loads given are for a two-member joint assembly with one split-ring, a bolt, two washers and a nut.

MULTIPLE SPLIT-RING LOADS

For a joint assembly in which more than one split-ring of the same or of different sizes are used in the contact faces concentric with the same bolt axis or in which more than one bolt is used with split-rings on each bolt, the safe load is the sum of the loads given for each ring used.

CONCENTRIC PLACEMENT BETWEEN SAME TIMBER SURFACES

When grooves for two sizes of split rings are cut, concentric in the same timber surface, rings shall be installed in both grooves and the allowable load shall be equal to the tabulated load for the larger ring only.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on split-rings may be taken as 130 per cent of the Standard Design Loads provided the resulting size or number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using the Standard Design Loads, the load on a split-ring due to a force producing impact shall be taken as 57.5 per cent of the sum of the force as a static load and the load due to its impact, but shall not be taken as less than the load caused by the force acting as a permanent static load; i. e., impact up to 74 per cent of the force producing impact may be neglected.



SPLIT-RING

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 4. Loads for end and edge distances and spacings intermediate of standard and minimum may be determined by interpolation.

LOAD AT ANGLE TO GRAIN

Loads at angles to grain intermediate of those in the table may be determined by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average total deformations in inches for split-ring joints from zero load to Standard Design Loads are as follows:

Split-Ring Number	Ring Diameter inches	Load Applied Parallel to grain inches	Load Applied Perpendicular to grain inches
1.....	2-1/2.....	.040.....	.050
2.....	4.....	.045.....	.055
3.....	6.....	.050†.....	.060†

†Estimated

STANDARD DESIGN LOADS FOR ONE SPLIT-RING AND BOLT IN SINGLE SHEAR

Species	SPLIT-RING		BOLT diameter (inches)	Lumber thickness (net) for Connectors used		Allowable LOAD in pounds per CONNECTOR and BOLT at angle of load to grain of						
	Number	diameter (inches)		In one face only	Opposite in two faces	0°	15°	30°	45°	60°	75°	90°
GROUP A Dense structural grades of Douglas Fir, Southern Pine	1	2 1/2	1/2	1" and thicker.....	1-5/8"..... 2" and thicker.....	2750 3300	2618 3142	2487 2983	2355 2825	2223 2667	2092 2508	1960 2350
	2	4	3/4*	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	4270 4500 5170 6300 6400	4058 4277 4914 5985 6080	3847 4053 4657 5670 5760	3635 3830 4401 5355 5440	3423 3607 4144 5040 5120	3212 3383 3887 4720 4800	3000 3160 3630 4410 4480
	3	6	3/4	1-5/8"..... 2" and thicker.....	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker.....	7000 8345 9155 10500	6533 7789 8544 9800	6067 7233 7933 9100	5600 6678 7323 8400	5133 6122 6712 7700	4667 5566 6101 7000	4200 5010 5490 6300
	1	2 1/2	1/2	1" and thicker.....	1-5/8"..... 2" and thicker.....	2375 2850	2258 2708	2140 2567	2023 2425	1905 2283	1788 2142	1670 2000
	2	4	3/4*	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	3660 3850 4430 5400 5500	3478 3658 4207 5130 5225	3297 3467 3983 4860 4950	3115 3275 3760 4590 4675	2933 3084 3537 4320 4400	2752 2892 3313 4050 4125	2570 2700 3090 3780 3850
	3	6	3/4	1-5/8"..... 2" and thicker.....	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker.....	6000 7155 7845 9000	5600 6678 7323 8400	5200 6200 6800 7800	4800 5723 6278 7200	4400 5245 5755 6600	4000 4768 5233 6000	3600 4290 4710 5400
GROUP B Non-dense structural grades of Douglas Fir, Southern Pine, structural grades of Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak	1	2 1/2	1/2	1" and thicker.....	1-5/8"..... 2" and thicker.....	2000 2400	1896 2275	1792 2150	1688 2025	1583 1900	1479 1775	1375 1650
	2	4	3/4*	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	3070 3230 3710 4500 4580	2913 3065 3522 4275 4350	2757 2900 3333 4050 4120	2600 2735 3145 3825 3890	2443 2570 2957 3600 3660	2287 2405 2768 3375 3430	2130 2240 2580 3150 3200
	3	6	3/4	1-5/8"..... 2" and thicker.....	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker.....	5000 5960 6540 7500	4667 5563 6104 7000	4333 5165 5668 6500	4000 4768 5233 6000	3667 4370 4797 5500	3333 3973 4361 5000	3000 3575 3925 4500
	1	2 1/2	1/2	1" and thicker.....	1-5/8"..... 2" and thicker.....	2000 2400	1896 2275	1792 2150	1688 2025	1583 1900	1479 1775	1375 1650
	2	4	3/4*	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	3070 3230 3710 4500 4580	2913 3065 3522 4275 4350	2757 2900 3333 4050 4120	2600 2735 3145 3825 3890	2443 2570 2957 3600 3660	2287 2405 2768 3375 3430	2130 2240 2580 3150 3200
	3	6	3/4	1-5/8"..... 2" and thicker.....	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker.....	5000 5960 6540 7500	4667 5563 6104 7000	4333 5165 5668 6500	4000 4768 5233 6000	3667 4370 4797 5500	3333 3973 4361 5000	3000 3575 3925 4500
GROUP C Structural grades of Cypress, Redwood	1	2 1/2	1/2	1" and thicker.....	1-5/8"..... 2" and thicker.....	2000 2400	1896 2275	1792 2150	1688 2025	1583 1900	1479 1775	1375 1650
	2	4	3/4*	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	3070 3230 3710 4500 4580	2913 3065 3522 4275 4350	2757 2900 3333 4050 4120	2600 2735 3145 3825 3890	2443 2570 2957 3600 3660	2287 2405 2768 3375 3430	2130 2240 2580 3150 3200
	3	6	3/4	1-5/8"..... 2" and thicker.....	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker.....	5000 5960 6540 7500	4667 5563 6104 7000	4333 5165 5668 6500	4000 4768 5233 6000	3667 4370 4797 5500	3333 3973 4361 5000	3000 3575 3925 4500
	1	2 1/2	1/2	1" and thicker.....	1-5/8"..... 2" and thicker.....	2000 2400	1896 2275	1792 2150	1688 2025	1583 1900	1479 1775	1375 1650
	2	4	3/4*	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	3070 3230 3710 4500 4580	2913 3065 3522 4275 4350	2757 2900 3333 4050 4120	2600 2735 3145 3825 3890	2443 2570 2957 3600 3660	2287 2405 2768 3375 3430	2130 2240 2580 3150 3200
	3	6	3/4	1-5/8"..... 2" and thicker.....	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker.....	5000 5960 6540 7500	4667 5563 6104 7000	4333 5165 5668 6500	4000 4768 5233 6000	3667 4370 4797 5500	3333 3973 4361 5000	3000 3575 3925 4500

* Loads for the No. 2, 4" split-ring may be increased 3-1/2% and 7% in lumber 2-5/8" thick and 5-1/2% and 10% in lumber 3" thick for 7/8" and 1" bolts, respectively, when used in place of the 3/4" bolt; also, loads for 4" split-rings when used with 7/8" and 1" bolts in lumber 3-5/8" thick or thicker may be taken as 112% and 119% respectively of the tabulated loads for the connector with 3/4" bolt in 3" material.

Basic values for split-rings, from which Standard Design Loads for the different thicknesses of lumber were derived, for Group B species parallel to the grain are 2480 lbs., 4785 lbs. and 7820 lbs., and perpendicular to the grain are 1740 lbs., 3350 lbs. and 4700 lbs. for the Nos. 1, 2 and 3 split-rings respectively. Values for Group A species are approximately 16 per cent greater and values for Group C species are approximately 16 per cent less than those for Group B species. For wind loads basic values may be increased 50 per cent and impact up to 100 per cent of the force producing impact may be neglected.

TIMBER CONNECTORS—TOOTHED-RINGS DESIGN DATA

TOOTHED-RING , Order Number.....	1	2	3	4
(All dimensions in inches)				
Diameter.....	2	2-5/8	3-3/8	4
Thickness of metal.....	.061	.061	.061	.061
Depth.....	.94	.94	.94	.94
Depth of fillet, minimum.....	.25	.25	.25	.25
Shipping weight, per 100 rings, lbs.....	9.0	12.0	15.0	18.0
LUMBER DIMENSIONS , minimum required for installation of rings				
Face width, standard and minimum.....	3	3-5/8	4-5/8	5-1/2
Thickness, rings in one face only.....	1	1	1	1
Thickness, rings opposite in both faces.....	1-5/8	1-5/8	1-5/8	1-5/8
BOLT , diameter, minimum.....	1/2	5/8	3/4	3/4
Diameter for rings of different size placed on same bolt.....	Use minimum for larger ring			
BOLT HOLE , maximum diameter in timber.....	9/16	11/16	13/16	13/16
WASHERS , minimum				
Round, cast or malleable iron, diameter.....	2	2-5/8	3	3-1/2
Square plate				
Length of side.....	2	2-1/2	3	3-1/2
Thickness.....	3/16	1/4	1/4	3/8
SPACING OF TOOTHED-RINGS , center to center				
0°-30° angle of load to grain				
Spacing parallel to grain, standard, for full allowable load.....	3-1/2	4-1/2	5-3/4	7
Spacing parallel to grain, intermediate, reduce loads 25% except for one ring.....	3-1/4	4-1/8	5-1/8	6
Spacing parallel to grain, minimum, reduce loads 50% except for one ring.....	3	3-5/8	4-3/8	5
Spacing perpendicular to grain, standard and minimum.....	2-1/2	3-1/8	3-7/8	4-1/2
30°-90° angle of load to grain				
Spacing parallel to grain.....	2-1/2	3-1/8	3-7/8	4-1/2
Spacing perpendicular to grain.....	3	3-1/2	4-1/2	5-1/2
END DISTANCES , center of ring to end of piece				
Tension members, standard, for full allowable load.....	3-1/2	4-1/2	5-3/4	7
Tension members, minimum, reduce load 33%.....	2	2-5/8	3-3/8	4
With cross bolt between ring and end of piece, the full load may be used with distances of.....	2	2-5/8	3-3/8	4
Compression members, standard and minimum.....	2	2-5/8	3-3/8	4
EDGE DISTANCES , center of ring to edge of piece				
0°-30° angle of load to grain.....	1-1/2	1-3/4	2-1/4	2-3/4
30°-90° angle of load to grain, standard.....	2	2-1/2	3	3-1/2
30°-90° angle of load to grain, minimum, reduce load 15%.....	1-1/2	1-3/4	2-1/4	2-3/4
PROJECTED AREA for portion of one ring within member, square inches..	.94	1.23	1.59	1.88



TOOTHED-RING



SINGLE TOOTHED-RING JOINT ASSEMBLY

Toothed-ring in one face of each member



MULTIPLE TOOTHED-RING JOINT ASSEMBLY

Toothed-rings opposite in both faces of middle members; in one face of side members

(Single bolt and more than one ring)



MULTIPLE TOOTHED-RING JOINT ASSEMBLY

Toothed-rings in one face of each member

(More than one bolt with ring on each bolt)

TOOTHED-RING SPECIFICATIONS

Toothed-ring timber connectors shall be stamped cold from U. S. Standard 16 gage hot rolled sheet steel conforming to A.S.T.M. Standard Specifications for carbon steel A 17-29, Type A, Grade 1, and shall be bent cold to form a circular, corrugated, sharp-toothed band and welded into a solid ring. The teeth on each ring shall be on a true circle and shall be parallel to the axis of the ring. The central band shall be welded to fully develop the strength of the band. Toothed-rings shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to toothed-rings used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface. Loads for toothed-rings in green lumber (24 per cent or more moisture content) should not exceed 60 per cent of those shown; for intermediate moisture contents between 24 per cent and 15 per cent, interpolate according to the percentage of moisture content of the timber surface.

TIMBER CONNECTORS—TOOTHED-RINGS—SAFE LOADS

SINGLE TOOTHED-RING LOADS

The loads given are for a two-member joint assembly with one toothed-ring, a bolt, two washers and a nut.

MULTIPLE TOOTHED-RING LOADS

For a joint assembly in which more than one toothed ring of the same or of different sizes are used in the contact faces concentric with the same bolt axis or in which more than one bolt is used with toothed-rings on each bolt, the safe load is the sum of the loads given for each ring used.

CONCENTRIC PLACEMENT BETWEEN SAME TIMBER SURFACE

Two toothed-rings in combination of the sizes Nos. 1 and 3, Nos. 1 and 4, or Nos. 2 and 4 may be placed concentrically to the same bolt between the same timber surfaces. These combinations result in a total load value equal to the tabulated load for the larger ring plus 25 per cent of the tabulated load for the smaller ring.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on toothed-rings may be taken as 116 per cent of the Standard Design Loads, provided the resulting size and number of connectors are not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a toothed-ring due to a force producing impact shall be taken as 115% of the sum of the force as a static load and the load due to its impact.

LOADS AT ANGLE TO GRAIN

Loads at angle to grain intermediate of those given in the table may be determined by interpolation.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 6. Loads for end and edge distances and spacings intermediate of standard and minimum may be obtained by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average deformations in inches for toothed-ring joints from zero load to Standard Design Loads are as follows:



TOOTHED-RING

Toothed-Ring Number	Ring Diameter inches	Load Applied	
		Parallel to grain inches	Perpendicular to grain inches
1.....	2.....	.004.....	.006
2.....	2-5/8.....	.006†.....	.008†
3.....	3-3/8.....	.008.....	.010†
4.....	4.....	.010.....	.012†

† Estimated.

STANDARD DESIGN LOADS FOR ONE TOOTHED-RING AND BOLT IN SINGLE SHEAR

Species	TOOTHED-RING		BOLT diameter (inches)	Lumber thickness (net) for Connectors used		Allowable LOAD in pounds per CONNECTOR and BOLT at angle of load to grain of						
	Number	diameter (inches)		In one face only	Opposite in two faces	0°	7½°	15°	22½°	30°	37½°	45°-90°
GROUP A Dense structural grades of Douglas Fir, Southern Pine	1	2	½*	1" and thicker.....	1-5/8"..... 2" and thicker.....	1265 1390	1213 1332	1160 1273	1108 1215	1055 1157	1003 1098	950 1040
	2	2½	5/8	1".....	1-5/8"..... 2".....	1580 1900 2100 2370	1514 1821 2013 2273	1448 1742 1925 2175	1382 1663 1838 2078	1317 1583 1750 1980	1251 1504 1663 1883	1185 1425 1575 1785
	3	3¾	¾	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	2225 2470 2705 3100 3335	2133 2367 2593 2970 3196	2040 2263 2480 2840 3057	1948 2160 2368 2710 2918	1855 2057 2255 2580 2778	1763 1953 2143 2450 2639	1670 1850 2030 2320 2500
	4	4	¾	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	2575 2970 3215 3620 3860	2468 2847 3081 3469 3699	2360 2723 2947 3317 3537	2253 2600 2813 3165 3375	2145 2477 2678 3013 3213	2038 2353 2544 2862 3052	1930 2230 2410 2710 2890
GROUP B Non-dense structural grades of Douglas Fir, Southern Pine; structural grades of Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak	1	2	½*	1" and thicker.....	1-5/8"..... 2" and thicker.....	1150 1265	1103 1213	1055 1160	1008 1108	960 1055	913 1003	865 950
	2	2½	5/8	1".....	1-5/8"..... 2".....	1435 1725 1910 2155	1375 1654 1830 2066	1315 1582 1750 1977	1255 1510 1670 1888	1195 1438 1590 1798	1135 1367 1510 1709	1075 1295 1430 1620
	3	3¾	¾	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	2020 2245 2460 2815 3030	1936 2151 2358 2698 2904	1852 2057 2255 2580 2777	1768 1963 2153 2463 2650	1683 1868 2050 2345 2523	1599 1774 1948 2228 2397	1515 1690 1845 2110 2270
	4	4	¾	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	2340 2700 2920 3290 3510	2243 2588 2799 3154 3364	2145 2475 2677 3017 3217	2048 2363 2555 2880 3070	1950 2250 2433 2743 2923	1853 2138 2312 2607 2777	1755 2025 2190 2470 2630
GROUP C Structural grades of Cypress, Redwood	1	2	½*	1" and thicker.....	1-5/8"..... 2" and thicker.....	1035 1140	992 1092	948 1043	905 995	862 947	818 898	775 850
	2	2½	5/8	1".....	1-5/8"..... 2"..... 2-1/2" and thicker..	1294 1555 1720 1940	1240 1490 1649 1859	1186 1425 1577 1778	1132 1360 1505 1697	1078 1295 1433 1617	1024 1230 1362 1536	970 1165 1290 1455
	3	3¾	¾	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	1815 2020 2210 2530 2725	1739 1936 2119 2425 2612	1663 1852 2027 2320 2498	1587 1768 1935 2215 2385	1512 1683 1843 2110 2272	1436 1599 1752 2005 2158	1360 1515 1660 1900 2045
	4	4	¾	1".....	1-5/8"..... 2"..... 2-5/8"..... 3" and thicker.....	2105 2430 2630 2960 3160	2018 2329 2520 2837 3029	1930 2227 2410 2713 2897	1843 2125 2300 2590 2765	1755 2023 2190 2467 2633	1668 1922 2080 2343 2502	1580 1820 1970 2220 2370

* Increase loads 20% when 5/8" bolt is used in place of ½" bolt.

Basic values for toothed-rings, from which Standard Design Loads for the different thicknesses of lumber were derived, for Group B species parallel to the grain are 1100 lbs., 1875 lbs., 2630 lbs. and 3055 lbs., and perpendicular to the grain are 825 lbs., 1405 lbs., 1970 lbs., and 2290 lbs. for the Nos. 1, 2, 3 and 4 toothed-rings respectively. Values for Group A species are 10 per cent greater and values for Group C species are 10 per cent less than those for Group B species. For wind loads basic values may be increased 33%.

TIMBER CONNECTORS—CLAW-PLATE DESIGN DATA

CLAW-PLATES, Order Number..... (All dimensions in inches)	1 Male	1A Female	2 Male	2A Female	3 Male	3A Female
Diameter.....	2-5/8	2-5/8	3-1/8	3-1/8	4	4
Depth of plate and teeth.....	.75	.75	.75	.75	.75	.75
Depth of outside hub.....	.37		.37		.37	
Diameter of outside hub.....	.87		.87		1.22	
Diameter of central hole.....	.53	.90	.53	.90	.78	1.25*
Shipping weight, per 100 claw-plates, lbs.	58	40	70	59	93	80
DIMENSIONS OF CIRCULAR DAP						
(A)	2.64	2.64	3.16	3.16	4.07	4.07
(B)	1.12	1.12	1.14	1.14	1.55	1.55
(C)	9/16	15/16	9/16	15/16	13/16	1-1/4
(D)	.52	.52	.76	.76	1.01	1.01
(E)	.25	.25	.25	.25	.25	.25
(F)	.38	.38	.38	.38	.38	.38
(G)	.22	.22	.22	.22	.28	.28
(H)	.42	.42	.42	.42	.45	.45
LUMBER DIMENSIONS, minimum required for installation of plates						
Face width.....	3-5/8	3-5/8	4-5/8	4-5/8	5-1/2	5-1/2
Thickness, plates in one face only.....	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8	1-5/8
Thickness, plates opposite in both faces.....	2	2	2	2	2	2
STEEL STRAPS OR SHAPES used in combina- tion with claw-plates						
Standard thickness.....	3/8	3/8	3/8	3/8	3/8	3/8
Minimum, (washers must be used to take up difference in hub depth of male claw-plate)	1/4	1/4	1/4	1/4	1/4	1/4
HOLE, diameter in straps or plates.....	29/32	29/32	29/32	29/32	1-1/4	1-9/32
BOLT, diameter when male plates are used singly or male & female are used in combination..	1/2		1/2		3/4	
Diameter when female plates are used without male plates.....		7/8		7/8		1-1/4
BOLT HOLE, diameter in timber when male plates or a combination of male & female plates are used.....	9/16		9/16		13/16	
Diameter when female plates are used without male plates.....		15/16		15/16		1-5/16
WASHERS, minimum						
Timber-to-Timber Connections						
Round, cast or malleable iron, diameter.....	2-1/8	3-1/2	2-1/8	3-1/2	3	4-3/8
Square plate: Length of side.....	2	3	2	3	3	4
Thickness.....	3/16	1/4	3/16	1/4	3/8	3/8
Timber-to-Steel Connections						
Round wrought iron: Diameter.....	2	2	2	2	4	4
Thickness.....	5/32	5/32	5/32	5/32	11/64	11/64
SPACING OF CLAW-PLATES, center to center						
0°-30° angle of load to grain						
Spacing parallel to grain, standard.....	6-3/4	6-3/4	7-3/4	7-3/4	9	9
Spacing parallel to grain, intermediate, reduce loads 25% except for one ring...	5	5	6	6	6-7/8	6-7/8
Spacing parallel to grain, minimum, reduce loads 50% except for one ring.....	3-3/8	3-3/8	4	4	4-7/8	4-7/8
Spacing perpendicular to grain, standard and minimum.....	3 1/2	3-1/2	4-1/4	4-1/4	5-1/2	5-1/2
30°-90° angle of load to grain						
Spacing parallel to grain, standard and minimum.....	3-1/2	3-1/2	4-1/4	4-1/4	5 1/2	5-1/2
Spacing perpendicular to grain, standard..	4-1/2	4-1/2	5-1/4	5-1/4	6-1/2	6-1/2
Spacing perpendicular to grain, minimum, reduce loads 15%.....	3-1/2	3-1/2	4-1/4	4-1/4	5-1/2	5-1/2
END DISTANCES, center of plate to end of piece						
Tension members, standard.....	5-1/2	5-1/2	6	6	7	7
Tension members, minimum, reduce load 37.5%.....	2-3/4	2-3/4	3	3	3-1/2	3-1/2
With cross bolt between claw-plate and end of piece, full load may be used with distances of.....	4	4	4-1/2	4-1/2	5-1/2	5-1/2
Compression members, standard.....	4	4	4-1/2	4-1/2	5-1/2	5-1/2
Compression members, minimum, reduce load 37.5%.....	3	3	3-1/2	3-1/2	4-1/2	4-1/2
EDGE DISTANCES, center of plate to edge of piece						
0°-30° angle of load to grain, standard and minimum.....	1-3/4	1-3/4	2-1/8	2-1/8	2-3/4	2-3/4
30°-90° angle of load to grain, standard on compression side of plate.....	2-3/4	2-3/4	3-1/8	3-1/8	3-3/4	3-3/4
Minimum distance, reduce load 15%.....	1-3/4	1-3/4	2-1/8	2-1/8	2-3/4	2-3/4
30°-90° angle of load to grain, standard and minimum, opposite compression side of plate	1-3/4	1-3/4	2-1/8	2-1/8	2-3/4	2-3/4
PROJECTED AREA for one claw-plate only, Square inches.....	1.97	1.97	2.34	2.34	3.00	3.00



WOOD-TO-WOOD JOINT

Claw-plate in one face of each member

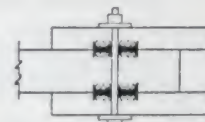
(One unit—one claw-plate with and one without hub)



WOOD-TO-STEEL JOINT

Claw-plate in one face of wood member

(One unit—one claw-plate only with hub)



MULTIPLE CLAW-PLATE JOINT

Claw-plates opposite in both faces of middle members; in one face of side members

(Two units of claw-plates)



MULTIPLE CLAW-PLATE UNIT JOINT

Claw-plates in one face of each member

(More than one bolt with claw-plates on each bolt)

CLAW-PLATE SPECIFICATIONS

Claw-plate timber connectors shall be malleable iron castings, manufactured according to A.S.T.M. Standard Specifications A 47-33, Grade 35018. Each claw-plate shall consist of a perforated circular flanged plate with three-sided teeth arranged about the perimeter of one face. The male plate shall have integral cylindrical hubs on both faces concentric to a bolt hole through the center of the plate. The female plate shall be flat on the side opposite the teeth but shall have an integral cylindrical hub concentric to the central bolt hole and on the face with the teeth. Claw-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to claw-plates used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface or in green material which will reach this condition in the structure within a reasonable period of time. If used in green material which will stay wet, use 67 per cent of the tabulated loads.

* When used without male plate and with 1-1/4" bolt, ream hole to 1-5/16".

TIMBER CONNECTORS—CLAW-PLATES—SAFE LOADS

CLAW-PLATE WORKING LOADS

Loads given are for a two member joint assembly with a single connector unit (a unit may consist of two plates, male and female in combination, or of two female plates used back to back in the contact faces of a timber-to-timber joint, or of one male or one female plate used in conjunction with a steel strap or shape in a timber-to-metal joint) used with a bolt, two washers and a nut.

MULTIPLE CLAW-PLATE LOADS

For a joint assembly in which more than one claw-plate unit is used with the same bolt or in which more than one bolt is used with claw-plates on each bolt, the safe load is the sum of the loads for all the units.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on claw-plates may be taken as 116% of the Standard Design Loads parallel to the grain and as 130% of the Standard Design Loads perpendicular to grain with loads at intermediate angles to the grain obtained by interpolation, provided the resulting size and number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a claw-plate unit due to a force producing impact shall be taken as 115% of the sum of the force as a static load and the load due to its impact.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 8. Loads for end and edge distances and spacings intermediate of standard and minimum may be determined by interpolation.



FEMALE CLAW-PLATE

LOAD AT ANGLE TO GRAIN

Loads at angles to grain intermediate of those in the table may be determined by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average deformations in inches for claw-plate joints from zero load to Standard Design Loads are as follows:

Claw-plate Number	Plate Diameter inches	Load Applied Parallel to grain inches	Load Applied Perpendicular to grain inches
1 and 1A....	2-5/8.....	.015.....	.023
2 and 2A....	3-1/8.....	.038.....	.045
3 and 3A....	4.....	.038.....	.045

STANDARD DESIGN LOADS FOR ONE CLAW-PLATE UNIT AND BOLT IN SINGLE SHEAR

Species	CLAW-PLATE		BOLT diameter (inches)	Lumber thickness (net) for Connectors used		Allowable LOAD in pounds per CONNECTOR UNIT and BOLT at angle of load to grain of						
	Number	diameter (inches)		In one face only	Opposite in two faces	0°	15°	30°	45°	60°	75°	90°
GROUP A Dense structural grades of Douglas Fir, Southern Pine	1	2 ⁵ / ₈	1/2	1-5/8" and thicker...	2"..... 2-5/8" and thicker..	2400 3600	2302 3453	2203 3307	2105 3160	2007 3013	1908 2867	1810 2720
	2	3 ¹ / ₈	1/2	1-5/8" and thicker...	2"..... 2-5/8"..... 3" and thicker.....	3130 4110 4700	3003 3944 4510	2877 3778 4320	2750 3612 4130	2623 3447 3940	2497 3281 3750	2370 3115 3560
	3	4	3/4	1-5/8"..... 1-3/4" and thicker...	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	3990 4820 5320 5980	3833 4631 5111 5745	3677 4441 4903 5510	3520 4252 4693 5275	3363 4063 4483 5040	3207 3874 4274 4805	3050 3685 4065 4570
GROUP B Non-dense structural grades of Douglas Fir, Southern Pine; structural grades of Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak	1	2 ⁵ / ₈	1/2	1-5/8" and thicker...	2"..... 2-5/8" and thicker..	2090 3130	2003 3002	1917 2873	1830 2745	1743 2617	1657 2483	1570 2360
	2	3 ¹ / ₈	1/2	1-5/8" and thicker...	2"..... 2-5/8"..... 3" and thicker.....	2730 3580 4090	2618 3433 3923	2507 3288 3757	2395 3142 3590	2283 2997 3423	2172 2851 3257	2060 2705 3070
	3	4	3/4	1-5/8"..... 1-3/4" and thicker...	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	3470 4190 4620 5200	3333 4025 4438 4995	3197 3860 4257 4790	3060 3695 4075 4585	2923 3530 3893 4380	2787 3365 3712 4175	2650 3200 3530 3970
GROUP C Structural grades of Cypress, Redwood	1	2 ⁵ / ₈	1/2	1-5/8" and thicker...	2"..... 2-5/8" and thicker..	1770 2660	1710 2568	1650 2477	1590 2385	1530 2293	1470 2202	1410 2110
	2	3 ¹ / ₈	1/2	1-5/8" and thicker...	2"..... 2-5/8"..... 3" and thicker.....	2310 3035 3470	2217 2913 3330	2123 2790 3190	2030 2668 3050	1937 2545 2910	1843 2423 2770	1750 2300 2630
	3	4	3/4	1-5/8"..... 1-3/4" and thicker...	2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	2950 3560 3930 4420	2833 3419 3775 4245	2717 3278 3620 4070	2600 3137 3465 3895	2483 2997 3310 3720	2367 2856 3155 3545	2250 2715 3000 3370

Basic values for claw-plates, from which Standard Design Loads for the different thicknesses of lumber were derived, for Group B species parallel to the grain are 2730 lbs., 3560 lbs. and 4520 lbs., and perpendicular to the grain are 2050 lbs., 2670 lbs. and 3450 lbs. for the Nos. 1 and 1A, 2 and 2A, and 3 and 3A claw-plates respectively. Values for Group A species are 15 per cent greater and values for Group C species are 15 per cent less than those for Group B species. For wind loads basic values may be increased 33-1/3 per cent.

TIMBER CONNECTORS—SHEAR-PLATE DESIGN DATA

SHEAR-PLATES, Order Number.....	1 Pressed Steel	2 Malle- able Iron	2-A* Malle- able Iron
Material.....			
(All dimensions in inches)			
Diameter of plate.....	2-5/8"	4"	4"
Diameter of bolt hole.....	.81	.81	.94
Thickness of plate.....	.169	.20	.20
Depth of flange.....	.375	.62	.62
Shipping weight, per 100 plates, lbs.....	40	100	100
DIMENSIONS OF CIRCULAR DAP			
(A).....	2.63	4.03	4.03
(B).....	1.55	1.55	1.55
(C).....	13/16	13/16	15/16
(D).....	.97	.97	.97
(E).....	.19	.27	.27
(F).....	.45	.64	.64
(G).....	.25	.22	.22
(H).....	.50	.50	.50
(I).....	2.25	3.49	3.49
LUMBER DIMENSIONS, minimum required for installation of plates			
Face width.....	3-5/8	5-1/2	5-1/2
Thickness, plates in one face only.....	1	1-5/8	1-5/8
Thickness, plates opposite in both faces.....	1-5/8	1-3/4	1-3/4
STEEL STRAPS OR SHAPES used in combination with shear-plates			
Minimum thickness, plates on one face of straps or shapes.....	1/4	3/8	3/8
Minimum thickness, plates opposite on both faces of straps or shapes.....	1/2	3/4	3/4
Hole diameter in straps or shapes for bolts.....	13/16	13/16	15/16
BOLT, diameter.....	3/4	3/4	7/8
BOLT HOLE, diameter in timber.....	13/16	13/16	15/16
WASHERS, standard			
Round, cast or malleable iron, diameter.....	3	3	3-1/2
Round, wrought iron (minimum, for use in simple structures):			
Diameter.....	2	2	2-1/4
Thickness.....	5/32	5/32	11/64
Square plate:			
Length of side.....	3	3	3
Thickness.....	1/4	1/4	1/4
SPACING OF SHEAR-PLATES, center to center			
0°-30° angle of load to grain			
Spacing parallel to grain, standard for full allowable load.....	6-3/4	9	9
Spacing parallel to grain, intermediate, reduce loads 25% except for one ring.....	5	6-7/8	6-7/8
Spacing parallel to grain, minimum, reduce loads 50% except for one ring.....	3-3/8	4-7/8	4-7/8
Spacing perpendicular to grain, standard and minimum.....	3-1/2	5-1/2	5-1/2
30°-90° angle of load to grain			
Spacing parallel to grain, standard and minimum.....	3-1/2	5-1/2	5-1/2
Spacing perpendicular to grain, standard.....	4-1/2	6-1/2	6-1/2
Spacing perpendicular to grain, minimum, reduce loads 15%.....	3-1/2	5-1/2	5-1/2
END DISTANCES, center of plate to end of piece			
Tension members, standard.....	5-1/2	7	7
Tension members, minimum, reduce load 37.5%.....	2-3/4	3-1/2	3-1/2
With cross bolt between plate and end of piece, full load may be used with distances of.....	4	5-1/2	5-1/2
Compression members, standard.....	4	5-1/2	5-1/2
Compression members, minimum, reduce load 37.5%.....	2-1/2	3-1/4	3-1/4
EDGE DISTANCES, center of plate to edge of piece			
0°-30° angle of load to grain, standard and minimum.....	1-3/4	2-3/4	2-3/4
30°-90° angle of load to grain, standard on compression side of plate.....	2-3/4	3-3/4	3-3/4
Minimum distance, reduce load 15%.....	1-3/4	2-3/4	2-3/4
30°-90° angle of load to grain, standard and minimum, opposite compression side of plate.....	1-3/4	2-3/4	2-3/4
PROJECTED AREA for one shear-plate, square inches.....	0.98	2.48	2.48

SHEAR-PLATE SPECIFICATIONS

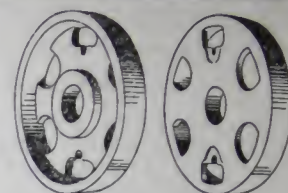
Pressed Steel Type—Pressed steel shear-plates shall be manufactured from mild steel conforming to A.S.T.M. Standard Specifications for carbon steel A 17-29, Type A, Grade 1. Each plate shall be a true circle with a flange around the edge, extending at right angles to the face of the plate and extending from one face only, the plate portion having a central bolt hole and two small perforations on opposite sides of the hole and midway from the center and circumference. Shear-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

Malleable Iron Type—Malleable iron shear-plates shall be manufactured according to A.S.T.M. Standard Specifications A 47-33, Grade 35018, for malleable iron castings. Each casting shall consist of a perforated round plate with a flange around the edge extending at right angles to the face of the plate and projecting from one face only, the plate portion having a central bolt hole reamed to size with an integral hub concentric to the bolt hole and extending from the same face as the flange. Shear-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to shear-plates used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface or in green lumber which will reach this condition in the structure within a reasonable period of time. If used in green lumber which will stay wet, use 67 per cent of the tabulated loads.

* Shear-plate No. 2-A is identical with No. 2 except for size of bolt hole.



MALLEABLE IRON SHEAR-PLATES



WOOD-TO-WOOD JOINT

Shear-plate in one face of each member

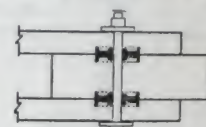
(One unit, two shear-plates back-to-back)



WOOD-TO-STEEL JOINT

Shear-plate in one face of wood member

(One unit, one shear-plate only)



MULTIPLE SHEAR-PLATE JOINT

Shear-plates opposite in both faces of middle members; in one face of side member

(Two units of shear-plates)



MULTIPLE SHEAR-PLATE UNIT JOINT

(More than one bolt with shear-plates on each bolt)

TIMBER CONNECTORS—SHEAR-PLATES—SAFE LOADS

SHEAR-PLATE WORKING LOADS

The loads given are for a two member joint assembly with a single connector unit (a unit may consist either of two plates used back-to-back in the contact faces of a timber-to-timber joint or of one plate used in conjunction with a steel strap or shape in a timber-to-metal joint) used with a bolt, two washers and a nut.

MULTIPLE SHEAR-PLATE LOADS

For a joint assembly in which more than one shear-plate unit is used with specified bolt and washer sizes, the total safe load capacity of the connectors is equal to the sum of the loads for all the units.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on shear-plates may be taken as 116% the Standard Design Loads parallel to the grain and as 130% of the Standard Design Loads perpendicular to grain with loads at intermediate angles to grain obtained by interpolation, provided the resulting size or number of connectors is not less than required for the dead and live loads alone.

IMPACT

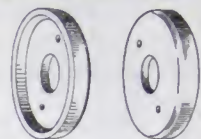
When using Standard Design Loads, the load on a shear-plate due to a force producing impact shall be taken as 115% of the sum of the force as a static load and the load due to its impact.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 10. Loads for end and edge distances and spacings intermediate of standard and minimum may be determined by interpolation.

LOAD AT ANGLE TO GRAIN

Loads at angles to grain intermediate of those in the table may be determined by interpolation.



PRESSED STEEL SHEAR-PLATES

DEFORMATION OF JOINTS UNDER LOAD

The average total deformations in inches for shear-plate joints from zero load to Standard Design Loads are as follows:

Shear-Plate Number	Plate Diameter Inches	Bolt Diameter Inches	Load Applied	
			Parallel to grain inches	Perpendicular to grain inches
1.....	2-5/8.....	3/4.....	.073.....	.100
2.....	4.....	3/4.....	.098.....	.102
2-A.....	4.....	7/8.....	.050.....	.090

STANDARD DESIGN LOADS FOR ONE SHEAR-PLATE UNIT AND BOLT IN SINGLE SHEAR

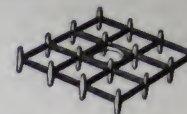
Species	SHEAR-PLATE		BOLT diameter (inches)	Lumber thickness (net) for Connectors used		Allowable LOAD in pounds per CONNECTOR UNIT and BOLT at angle of load to grain of						
	Number	diameter (inches)		In one face only	Opposite in two faces	0°	15°	30°	45°	60°	75°	90°
GROUP A Dense structural grades of Douglas Fir, Southern Pine	1	2 ⁵ / ₈	3/4	1" and thicker.....	1-5/8"..... 2" and thicker.....	2880 3450	2760 3307	2640 3163	2520 3020	2400 2877	2280 2733	2160 2590
	2	4	3/4	1-5/8" and thicker...	1-3/4"..... 2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	4250 4600 5080 5080 5080	4003 4333 5080 5080 5080	3757 4067 4853 5080 5080	3510 3800 4535 4975 5080	3263 3533 4217 4627 4897	3017 3267 3898 4278 4528	2770 3000 3580 3930 4160
	2-A	4	7/8		1-3/4"..... 2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	4250 4600 5490 6020 6370	4003 4333 5172 5672 6002	3757 4067 4853 5323 5633	3510 3800 4535 4975 5265	3263 3533 4217 4627 4897	3017 3267 3898 4278 4528	2770 3000 3580 3930 4160
GROUP B Non-dense structural grades of Douglas Fir, Southern Pine, structural grades of Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak	1	2 ⁵ / ₈	3/4	1" and thicker.....	1-5/8"..... 2" and thicker.....	2500 3000	2397 2875	2293 2750	2190 2625	2087 2500	1983 2375	1880 2250
	2	4	3/4	1-5/8" and thicker...	1-3/4"..... 2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	3700 4000 4760 5080 5080	3485 3768 4487 4920 5080	3270 3537 4213 4620 4887	3055 3305 3940 4320 4570	2840 3074 3667 4020 4253	2625 2842 3393 3720 3937	2410 2610 3120 3420 3620
	2-A	4	7/8		1-3/4"..... 2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	3700 4000 4760 5220 5520	3485 3768 4487 4920 5203	3270 3537 4213 4620 4887	3055 3305 3940 4320 4570	2840 3074 3667 4020 4253	2625 2842 3393 3720 3937	2410 2610 3120 3420 3620
GROUP C Structural grades of Cypress, Redwood	1	2 ⁵ / ₈	3/4	1" and thicker.....	1-5/8"..... 2" and thicker.....	2130 2550	2042 2443	1953 2337	1865 2230	1777 2123	1688 2017	1600 1910
	2	4	3/4	1-5/8" and thicker...	1-3/4"..... 2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	3140 3400 4050 4450 4710	2958 3203 3817 4193 4438	2777 3007 3583 3937 4167	2595 2810 3350 3680 3895	2413 2613 3117 3423 3623	2232 2417 2883 3167 3352	2050 2220 2650 2910 3080
	2-A	4	7/8		1-3/4"..... 2"..... 2-5/8"..... 3"..... 3-5/8" and thicker..	3140 3400 4050 4450 4710	2958 3203 3817 4193 4438	2777 3007 3583 3937 4167	2595 2810 3350 3680 3895	2413 2613 3117 3423 3623	2232 2417 2883 3167 3352	2050 2220 2650 2910 3080

Basic values for shear-plates, from which Standard Design Loads for the different thicknesses of lumber were derived, for Group B species parallel to the grain are 2610 lbs., 4420* lbs. and 4800 lbs. and perpendicular to the grain are 1955 lbs., 3150 lbs. and 3150 lbs. for the Nos. 1, 2 and 2A shear-plates respectively. Values for Group A species are 15 per cent greater and values for Group C species are 15 per cent less than for Group B species. For wind loads, basic values may be increased 33 per cent.

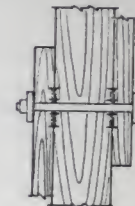
*While tests indicated a higher value parallel to grain for the joint assembly, the allowable shear for the 3/4 inch bolt (4420 lbs.) was assumed as the basic value in this instance. The type of failure in test indicated the 15 per cent increase applied to determine Standard Design Loads was justified.

TIMBER CONNECTORS—SPIKE-GRID DESIGN DATA

SPIKE-GRID, Order Number.....	1 Flat	2 Single Curve	3 Double Curve
Type.....			
(All dimensions in inches)			
Size, square.....	4-1/8	4-1/8	4-1/8
Total depth of grids, maximum.....	1	1.38	1.75
Length of spikes.....	.375	.375	.375
Width of fillets.....	.187	.187	.187
Maximum depth of fillets.....	.25	.63	1.00
Diameter of bolt hole.....	1.06	1.06	1.06
Shipping weight, per 100 grids, lbs.....	50	75	107
LUMBER DIMENSIONS , minimum recommended for installation of flat grids			
Face width.....	5-1/2	5-1/2	.....
Thickness.....	1-5/8	1-5/8	.....
Grids one face only.....	2	10	10
Grids opposite in both faces.....	.....	.....	.....
Minimum diameter of pile for curved grids.....	.....	.....	.....
BOLT , diameter.....	3/4 or 1	3/4 or 1	3/4 or 1
BOLT HOLE , diameter in timber.....	13/16 or 1-1/16	13/16 or 1-1/16	13/16 or 1-1/16
WASHERS	Standard Size for Bolt Diameter Used. 3x3x3/8 Punched for Bolt Diameter Used.		
Round, cast or malleable iron.....			
Square plate.....			
SPACING OF GRIDS , minimum, center to center			
0°-30° angle of load to grain			
Spacing parallel to grain.....	7	7	7
Spacing perpendicular to grain.....	5-1/2	5-1/2	5-1/2
30°-90° angle of load to grain			
Spacing parallel or perpendicular to grain.....	5-1/2	5-1/2	5-1/2
END DISTANCES , center of grid to end of piece (tension or compression members)			
Standard.....	7	7	7
Minimum, reduce loads 15%.....	5	5	5
EDGE DISTANCES , center of grid to edge of piece			
Load applied at any angle to grain			
Standard.....	3-3/4	3-3/4	3-3/4
Minimum, reduce loads 15%.....	2-3/4	2-3/4	2-3/4
PROJECTED AREA for portion of one grid within member, square inches...	2.06	2.06	2.06



FLAT SPIKE-GRID



FLAT SPIKE-GRID JOINT

*Spike-grids opposite in both faces
of middle member; in one face of
side members*

(Two braces attached to timber)

SPIKE-GRID SPECIFICATIONS

Spike-grid timber connectors shall be manufactured according to A.S.T.M. Standard Specifications A 47-33, Grade 35018, for malleable iron castings. They shall consist of four rows of opposing spikes forming a 4-1/8" square grid with 16 teeth which are held in place by fillets. Fillets for the flat grid in cross section shall be diamond shaped. Fillets for the single and double curve grids shall be increased in depth to allow for curvature and shall maintain a thickness between the sloping faces of the fillets equal to the width of the fillet. Spike-grids shall conform to the dimensions of those manufactured by the Timber Engineering Company.

CONDITION OF LUMBER

Tabulated loads apply to spike-grids used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of its surface. Loads for spike-grids in green lumber (24 per cent or more moisture content) should not exceed 60 per cent of those shown; for intermediate moisture contents between 24 per cent and 15 per cent, interpolate according to the percentage of moisture content of the timber surface.

TIMBER CONNECTORS—SPIKE-GRIDS—SAFE LOADS

SINGLE SPIKE-GRID LOADS

The loads given are for a two member joint assembly with one spike-grid a bolt, two washers and a nut.

MULTIPLE SPIKE-GRID LOADS

For a joint assembly in which more than one spike-grid of the same or of different types are used in the contact faces of the timbers the total safe load on the connectors is the sum of the loads given for each grid used.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on spike-grids may be taken as 130% of the Standard Design Loads provided the resulting size and number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a spike-grid due to a force producing impact shall be taken as 115% of the sum of the force as a static load and the load due to its impact.

LOADS IN RELATION TO DISTANCES AND SPACINGS

Standard Design Loads are for standard distances and spacings. Standard and minimum distances and spacings with load reduction factors are given in the table on page 12. Loads for end and edge distances and spacings intermediate of standard and minimum may be determined by interpolation.

LOAD AT ANGLE TO GRAIN

Loads at angles to grain intermediate of those in the table may be determined by interpolation.

DEFORMATION OF JOINTS UNDER LOAD

The average total deformations in inches for spike-grid joints from zero load to Standard Design Loads are as follows:

Spike Grid Number	Bolt Diameter inches	Load Applied	
		Parallel to grain inches	Perpendicular to grain inches
1.....	3/4.....	.012.....	.013
	1.....	.015.....	.021
2.....	3/4.....	.011.....	.020
	1.....	.018.....	.025
3.....	3/4.....	.011†.....	.020†
	1.....	.018†.....	.025†

†Estimated

STANDARD DESIGN LOADS* FOR ONE SPIKE-GRID AND BOLT IN SINGLE SHEAR

Species	SPIKE-GRID		BOLT diameter (inches)	Lumber thickness (net) and 10" minimum pile diameter for Connectors used		Allowable LOAD in pounds per CONNECTOR and BOLT at angle of load to grain of		
	Number	Size (inches)		In one face only	Opposite in two faces	0°	45°	90°
GROUP A Dense structural grades of Douglas Fir, Southern Pine	1, 2 and 3	4 1/8 × 4 1/8	3/4		2".....	3320	3000	2670
				1-5/8" and thicker...	2-5/8" and thicker..	4100	3700	3300
			1		2".....	3650	3285	2920
				1-5/8" and thicker...	2-5/8" and thicker..	4500	4050	3600
GROUP B Non-dense structural grades of Douglas Fir, Southern Pine, structural grades of Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak	1, 2 and 3	4 1/8 × 4 1/8	3/4		2".....	3160	2845	2430
				1-5/8" and thicker...	2-5/8" and thicker..	3900	3450	3000
			1		2".....	3440	3035	2630
				1-5/8" and thicker...	2-5/8" and thicker..	4250	3750	3250
GROUP C Structural grades of Cypress, Redwood	1, 2 and 3	4 1/8 × 4 1/8	3/4		2".....	2530	2100	1670
				1-5/8" and thicker...	2-5/8" and thicker..	3120	2590	2060
			1		2".....	2610	2170	1730
				1-5/8" and thicker...	2-5/8" and thicker..	3230	2680	2130

*Load values in the table are a conservative interpretation of a limited number of tests with a factor of safety of 4 on maximum test loads. Further investigation will probably show an increase for these values.



SINGLE CURVE SPIKE-GRID

TIMBER CONNECTORS—CLAMPING-PLATES

CLAMPING-PLATES, Order Number.....		1	2
Type.....		Plain	Flanged
(All dimensions in inches)			
Length of plate.....		5-1/4	8
Width of plate.....		5-1/4	5
Thickness of metal.....		.077	.122
Depth of flange.....			2
Number of teeth on each face.....		12	
Number of teeth on top face.....			14
Length of teeth.....		.68	.72
Diameter of bolt hole.....		1.12	1.12
Shipping weight per 100 pieces, lbs.....		65	200
LUMBER DIMENSIONS, minimum required for installation of plates			
Face width.....		6-1/2	6-1/2
Thickness, plates in one face only.....		1-5/8	2-5/8
Thickness, plates opposite on both faces.....		2-5/8	5-1/2
BOLT diameter, minimum.....		3/4	3/4
BOLT HOLE, diameter in timber.....		13/16	13/16
WASHERS			
Round, cast or malleable iron, diameter.....		3	3
Square plate:			
Length of side.....		3	3
Thickness.....		1/4	1/4
SPACING OF CLAMPING-PLATES			
Minimum center-to-center			
Parallel to grain.....		6	8-1/2
Perpendicular to grain.....		6	5-1/2
END DISTANCES			
Center of plate to end of piece			
Plain type.....		5	
Flanged type:			
Toothed side.....			5
Flanged side.....			2-1/2
EDGE DISTANCES			
Center of plate to edge of piece			
Plain type.....		3-1/4	
Flanged type:			
Toothed side.....			3-1/4
Flanged side.....			4

SINGLE CLAMPING-PLATE LOADS

The loads given are for a two member joint assembly with one plain or flanged clamping-plate either with or without a bolt through the joint as specified in the tables.

MULTIPLE CLAMPING-PLATE LOADS

For a joint assembly in which more than one clamping-plate is used, the total safe connector load is equal to the sum of the loads specified for the individual plates with or without bolts used in the joint.

WIND AND EARTHQUAKE LOADS

For wind or earthquake loads alone or a combination of wind or earthquake with dead or live loads or both, the safe loads on clamping-plates may be taken as 116 per cent of the Standard Design Loads provided the resulting number of connectors is not less than required for the dead and live loads alone.

IMPACT

When using Standard Design Loads, the load on a clamping-plate due to a force producing impact shall be taken as 115 per cent of the sum of the force as a static load and the load due to its impact.

LOADS IN RELATION TO DISTANCES AND SPACINGS

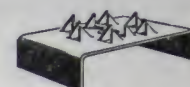
Standard Design Loads are for standard distances and spacings. Spacings of plates and end and edge distances less than the minimums specified are not recommended.

CONDITION OF LUMBER

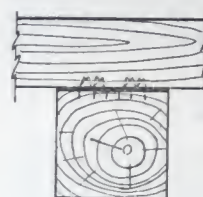
Tabulated loads apply to the plain clamping-plate (where the teeth rather than the flange determine the load capacity) used in seasoned lumber which has a moisture content not exceeding 15 per cent within 1/2" of the surface. Loads for the plain clamping-plates in green lumber (24 per cent or more moisture content) should not exceed 60 per cent of those shown; for intermediate moisture contents between 24 per cent and 15 per cent, interpolate according to the percentage of moisture content of the timber surface. Tabulated loads apply to the flanged clamping-plate in either seasoned or green lumber.



PLAIN CLAMPING-PLATE

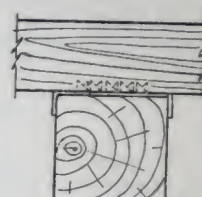


FLANGED CLAMPING-PLATE



← GUARD TIMBER →

← RAILROAD TIE →



CLAMPING-PLATES USED BETWEEN RAILROAD TIES AND GUARD TIMBERS

Plates may be used with a bolt through each joint or at every third or fourth joint.

DEFORMATION OF JOINTS UNDER LOAD

The average deformations in inches for clamping-plate joints from zero load to Standard Design Loads are as follows:

Clamping-Plate Number	Type of Connection	Load Applied Parallel to grain, inches	Load Applied Perpendicular to grain, inches
1.....	3/4" Bolt.....		.013
1.....	No Bolt.....		.013
2.....	Teeth Only.....	.019.....	
2.....	Flange Only.....		.025

CLAMPING-PLATE SPECIFICATIONS

Clamping-plate timber connectors shall be stamped cold from mild steel conforming to A.S.T.M. Standard Specifications for carbon steel A 17-29, Type A, Grade 1.

Plain Clamping-Plate—Plain clamping-plates shall consist of a square steel plate with a central bolt hole and twelve teeth projecting from each face. The flat sides of the teeth on each face shall be parallel to each other and arranged with the flat sides of the teeth on opposite faces of the plate at right angles to each other. Clamping-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

Flanged Clamping-Plate—Flanged clamping-plates shall consist of a rectangular steel plate with a central bolt hole around which fourteen teeth shall project from one face with their flat sides parallel to the long edges of the plate. The metal near the two narrow ends of the plate shall be bent at right angles to the plate and in a direction opposite to the teeth to form flanges. Flanged clamping-plates shall conform to the dimensions of those manufactured by the Timber Engineering Company.

STANDARD DESIGN LOADS PER CLAMPING-PLATE

Species	CLAMPING-PLATE		Type of Joint Connection	Angle of Load to grain 90°
	Number	Size (inches)		
GROUP A Dense structural grades of Douglas Fir, Southern Pine	1	5 1/4 x 5 1/4	3/4" Through Bolt	3,400
			No Through Bolt*	2,460
	2	5 x 8	Teeth Only (No Through Bolt)	2,920
GROUP B Non-dense structural grades of Douglas Fir, Southern Pine, structural grades of Western Larch, Tamarack, Ash, Beech, Birch, Maple, Oak	1	5 1/4 x 5 1/4	3/4" Through Bolt	3,080
			No Through Bolt	2,230
	2	5 x 8	Teeth Only (No Through Bolt)	2,660
GROUP C Structural grades of Cypress, Redwood	1	5 1/4 x 5 1/4	3/4" Through Bolt	2,770
			No Through Bolt	2,010
	2	5 x 8	Teeth Only (No Through Bolt)	2,390
			One Flange Only (No Through Bolt)	1,610

*Joint members held in contact by bolts outside joint area.

Basic values for clamping-plates, from which Standard Design Loads were derived for Group B species for timbers overlapping at right angles (90°) to the grain, are 2680 lbs. and 1940 lbs. for the plain clamping-plate with a 3/4" through bolt and with no through bolt respectively, and 2310 lbs. and 1400 lbs. for the flanged plate with teeth only and one flange only respectively. With the exception of the value for the flange only of the flanged-plate where the bending of the flange results in ultimate failure, values for Group A species are 10 per cent greater and for Group C species are 10 per cent less than those for Group B species. For wind loads basic values may be increased 33-1/3 per cent.

TIMBER CONNECTORS—NET SECTION OF TIMBERS—GALVANIZING SPECIFICATION

NET SECTION

The net section of a timber in a connector joint is usually adequate to transmit the full strength of the timber which can be developed outside of the joint when the lower grades of lumber are used. However, it may be desirable to check the strength of the net section of timbers when they are of the minimum size recommended herein for a given connector, particularly if a high stress-grade of lumber is used.

The critical or "net" section of a timber in a joint, which will generally pass through the center line of a bolt and connector, occurs at the plane of maximum stress. The net cross section at this plane is equal to the full cross-sectional area of the timber minus the projected area of that portion of the connectors within the member and that portion of the bolts, not within the connector projected area, located at this plane.



Shaded Area Shows Net Cross Section of Timber

Due to wood being able to support loads of short-time duration greatly in excess of permanently applied loads, computation of the required net section in tension or compression involves consideration of the different types and amounts of loadings. Constants in the table for Standard loading apply for the same loading conditions as described on page 3 for Standard Design Loads for connectors. Constants for wind or earthquake loads apply to wind and earthquake loads alone or when combined with live or dead loads or both; in which cases however the resulting net section shall not be less than required for dead and live loads alone. Constants for impact apply to that portion of impact which exceeds 100 per cent of the load producing the impact. Constants for dead load apply where the full design load is permanently applied.

The net cross sectional area in square inches required at the critical section may be determined by multiplying the total load in pounds, which is transferred through the critical section of the member, by the appropriate constant given in the table. Conversely, the total working load capacity in pounds of a given net area may be determined by dividing the net area in square inches by the appropriate constant.

*CONSTANTS FOR USE IN DETERMINING REQUIRED NET SECTION IN SQUARE INCHES

Type of Loading	Thickness of Wood Member in Inches	CONSTANTS FOR EACH CONNECTOR LOAD GROUP		
		Group A	Group B	Group C
Standard.....	4" or less.....	.00041	.00046	.00048
	over 4".....	.00051	.00058	.00060
Wind or Earthquake....	4" or less.....	.00031	.00036	.00037
	over 4".....	.00039	.00044	.00046
Impact.....	4" or less.....	.00023	.00027	.00028
	over 4".....	.00029	.00033	.00035
Dead Load.....	4" or less.....	.00047	.00053	.00055
	over 4".....	.00058	.00067	.00069

* The above constants, computed from basic recommendations of the Forest Products Laboratory, are based on a permissible tensile stress at the net section equal to the basic stress for clear wood in compression parallel to grain increased 25 per cent for the greater strength of dry material 4" and less in thickness and adjusted for the duration-of-loading effect by an increase of 15 per cent for standard loading, 50 per cent for wind or earthquake loading, and 100 per cent for impact loading.

The above recommendations assume the condition usually encountered, that a knot approaching the maximum size allowed for the grade will not occur at, or within one-half the connector diameter of, the plane of the critical section. When it is anticipated that knots approaching the maximum size may be present at or near the critical plane the critical section area must be further reduced by the projected area of the knot, excluding from the reduction any portion of the knot which is within the projected area of the connector or bolt.

For the clamping-plates, net section is generally not a factor in determining the size of the timbers in which they are used but it may be computed by subtracting the projected area of the bolt diameter only from the cross section, since the teeth of the plate, embedded with their flat sides parallel to the grain, cut only a small percentage of the wood fibers.

SPECIFICATION WHEN GALVANIZING IS REQUIRED

The Galvanizing specifications for all types of timber connectors shall conform to A.S.T.M. Standard Specifications for Galvanizing.

1. Zinc used in the bath shall be at least equal to "Prime Western."

2. The weight of the zinc coating per square foot of actual surface shall average not less than 2.0 oz. and no individual specimen shall show less than 1.8 oz., weight to be determined by stripping an entire piece by A.S.T.M. Standard Method A 90-33.

3. The zinc coating shall be adherent, smooth, continuous and thorough, except that uncoated spots on the tongue and groove surfaces in contact will not be cause for rejection. It shall be free from imperfections such as bumps, blisters, gritty areas, uncoated spots, acid and black spots, dross and flux.

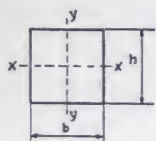
4. When visual inspection and testing with 1/2 lb. hammer is not conclusive, tests shall be made by the Preece method, in which case the minimum thickness of coating shall withstand at least seven 1-minute dips.

5. Test samples may be selected from deliveries at random and will be tested by the purchaser and at purchaser's expense.

PROJECTED AREA OF CONNECTORS AND BOLTS
(For Use in Determining Net Sections)

Connector No. | Size		Bolt Diam. (inches)	Placement of Connectors	Total Projected Area in Square Inches of Connectors and Bolts in Lumber Thickness of									
				1-5/8"	2"	2-5/8"	3"	3-5/8"	4"	5-1/2"	6"	7-1/2"	8"
SPLIT-RINGS													
1	2-1/2	1/2 1/2	One Face Two Faces	1.73 2.64	1.92 2.83	2.23 3.14	2.42 3.34	2.73 3.64	2.92 3.83	3.67 4.58	3.92 4.83	4.67 5.58	4.92 5.83
2	4	3/4 3/4	One Face Two Faces	3.09 4.97	3.37 5.25	3.84 5.72	4.12 6.00	4.59 6.47	4.87 6.75	6.00 7.16	6.37 8.25	7.50 9.38	7.87 9.75
3	6	3/4 3/4	One Face Two Faces	4.91	5.19 8.88	5.66 9.35	5.94 9.63	6.41 10.10	6.69 10.38	7.10 10.79	8.19 11.88	9.32 13.01	9.69 13.38
TOOTHED-RINGS													
1	2	1/2 1/2	One Face Two Faces	1.52 2.22	1.71 2.41	2.02 2.72	2.21 2.91	2.52 3.22	2.71 3.41	3.46 4.16	3.71 4.41	4.46 5.16	4.71 5.41
2	2-5/8	5/8 5/8	One Face Two Faces	1.95 2.89	2.18 3.12	2.58 3.52	2.81 3.75	3.20 4.14	3.44 4.38	4.37 5.31	4.69 5.63	5.62 6.56	5.94 6.88
3	3-3/8	3/4 3/4	One Face Two Faces	2.46 3.70	2.74 3.98	3.21 4.45	3.49 4.73	3.96 5.20	4.24 5.48	5.37 6.61	5.74 6.98	6.87 8.11	7.24 8.48
4	4	3/4 3/4	One Face Two Faces	2.75 4.28	3.03 4.56	3.50 5.03	3.78 5.31	4.25 5.78	4.53 6.06	5.66 7.19	6.03 7.56	7.16 8.69	7.53 9.06
CLAW-PLATES													
1 and 1A	2-5/8	1/2 1/2	One Face Two Faces	2.41	2.60 4.19	2.91 4.50	3.10 4.69	3.41 5.00	3.60 5.19	4.35 5.94	4.60 6.19	5.53 6.94	5.60 7.19
2 and 2A	3-1/8	1/2 1/2	One Face Two Faces	2.78	2.97 4.93	3.28 5.24	3.47 5.43	3.78 5.74	3.97 5.93	4.72 6.68	4.97 6.93	5.72 7.68	5.97 7.93
3 and 3A	4	3/4 3/4	One Face Two Faces	3.66	3.94 6.37	4.41 6.84	4.69 7.12	5.16 7.59	5.44 7.87	6.57 9.00	6.94 9.37	8.07 10.50	8.44 10.87
SHEAR-PLATES													
1	2-5/8	3/4 3/4	One Face Two Faces	1.92 2.62	2.20 2.90	2.67 3.37	2.95 3.65	3.42 4.12	3.70 4.40	4.83 5.53	5.20 5.90	6.33 7.03	6.70 7.40
2	4	3/4 3/4	One Face Two Faces	3.23	3.51 5.52	3.98 5.99	4.26 6.27	4.73 6.74	5.01 7.02	6.14 8.15	6.51 8.52	7.64 9.65	8.01 10.02
2-A	4	7/8 7/8	One Face Two Faces	3.36	3.69 5.62	4.24 6.17	4.56 6.49	5.11 7.04	5.44 7.37	6.75 8.68	7.19 8.12	8.50 10.43	8.94 10.87
SPIKE-GRIDS													
1, 2 and 3	4-1/8 x 4-1/8	3/4 3/4	One Face Two Faces	2.90	3.18 4.87	3.65 5.34	3.93 5.62	4.40 6.09	4.68 6.37	5.81 7.50	6.18 7.87	7.31 9.00	7.68 9.37
		1 1	One Face Two Faces	3.18	3.56 5.13	4.18 5.75	4.56 6.13	5.18 6.75	5.56 7.13	7.06 8.63	7.56 9.13	9.06 10.63	9.56 11.13

PROPERTIES OF LUMBER SIZES—LEGEND



DIMENSIONAL PROPERTIES OF AMERICAN STANDARD SIZES OF YARD LUMBER AND TIMBERS

NOMINAL SIZE b Inches h	AMERICAN STANDARD DRESSED SIZE (S4S) b Inches h	AREA OF SECTION (Sq. In.) $A = b \times h$	MOMENT OF INERTIA		SECTION MODULUS	
			$I_x - x = \frac{bh^3}{12}$	$I_y - y = \frac{b^3h}{12}$	$S_x - x = \frac{bh^2}{6}$	$S_y - y = \frac{b^2h}{6}$
2 x 4	1-5/8 x 3-5/8	5.89	6.45	1.30	3.56	1.60
2 x 6	1-5/8 x 5-5/8	9.14	24.10	2.01	8.57	2.48
2 x 8	1-5/8 x 7-1/2	12.19	57.13	2.68	15.23	3.30
2 x 10	1-5/8 x 9-1/2	15.44	116.10	3.40	24.44	4.18
2 x 12	1-5/8 x 11-1/2	18.69	205.95	4.11	35.82	5.06
2 x 14	1-5/8 x 13-1/2	21.94	333.18	4.83	49.36	5.94
2 x 16	1-5/8 x 15-1/2	25.19	504.27	5.54	65.07	6.82
2 x 18	1-5/8 x 17-1/2	28.44	725.75	6.25	82.94	7.70
3 x 4	2-5/8 x 3-5/8	9.52	10.42	5.46	5.75	4.16
3 x 6	2-5/8 x 5-5/8	14.77	38.93	8.48	13.84	6.46
3 x 8	2-5/8 x 7-1/2	19.69	92.29	11.30	24.61	8.61
3 x 10	2-5/8 x 9-1/2	24.94	187.55	14.32	39.48	10.91
3 x 12	2-5/8 x 11-1/2	30.19	332.69	17.33	57.86	13.21
3 x 14	2-5/8 x 13-1/2	35.44	538.21	20.35	79.73	15.50
3 x 16	2-5/8 x 15-1/2	40.69	814.60	23.36	105.11	17.80
3 x 18	2-5/8 x 17-1/2	45.94	1172.36	26.38	133.98	20.10
4 x 4	3-5/8 x 3-5/8	13.14	14.39	14.39	7.94	7.94
4 x 6	3-5/8 x 5-5/8	20.39	53.76	22.33	19.12	12.32
4 x 8	3-5/8 x 7-1/2	27.19	127.44	29.77	33.98	16.43
4 x 10	3-5/8 x 9-1/2	34.44	259.00	37.71	54.53	20.81
4 x 12	3-5/8 x 11-1/2	41.69	459.43	45.65	79.90	25.19
4 x 14	3-5/8 x 13-1/2	48.94	743.24	53.59	110.11	29.57
4 x 16	3-5/8 x 15-1/2	56.19	1124.92	61.53	145.15	33.95
4 x 18	3-5/8 x 17-1/2	63.44	1618.98	69.47	185.03	38.33
6 x 6	5-1/2 x 5-1/2	30.25	76.26	76.26	27.73	27.73
6 x 8	5-1/2 x 7-1/2	41.25	193.36	103.98	51.56	37.81
6 x 10	5-1/2 x 9-1/2	52.25	392.96	131.71	82.73	47.90
6 x 12	5-1/2 x 11-1/2	63.25	697.07	159.44	121.23	57.98
6 x 14	5-1/2 x 13-1/2	74.25	1127.67	187.17	167.06	68.06
6 x 16	5-1/2 x 15-1/2	85.25	1706.78	214.90	220.23	78.15
6 x 18	5-1/2 x 17-1/2	96.25	2456.38	242.63	280.73	88.23
8 x 8	7-1/2 x 7-1/2	56.25	263.67	263.67	70.31	70.31
8 x 10	7-1/2 x 9-1/2	71.25	535.86	333.98	112.81	89.06
8 x 12	7-1/2 x 11-1/2	86.25	950.55	404.30	165.31	107.81
8 x 14	7-1/2 x 13-1/2	101.25	1537.73	474.61	227.81	126.56
8 x 16	7-1/2 x 15-1/2	116.25	2327.42	544.92	300.31	145.31
8 x 18	7-1/2 x 17-1/2	131.25	3349.61	615.23	382.81	164.06
10 x 10	9-1/2 x 9-1/2	90.25	678.76	678.76	142.90	142.90
10 x 12	9-1/2 x 11-1/2	109.25	1204.03	821.65	209.40	172.98
10 x 14	9-1/2 x 13-1/2	128.25	1947.80	964.55	288.56	203.06
10 x 16	9-1/2 x 15-1/2	147.25	2948.07	1107.44	380.40	233.15
10 x 18	9-1/2 x 17-1/2	166.25	4242.84	1250.34	484.90	263.23
12 x 12	11-1/2 x 11-1/2	132.25	1457.51	1457.51	253.48	253.48
12 x 14	11-1/2 x 13-1/2	155.25	2357.88	1710.98	349.31	297.56
12 x 16	11-1/2 x 15-1/2	178.25	3568.71	1964.46	460.48	341.65
12 x 18	11-1/2 x 17-1/2	201.25	5136.07	2217.94	586.98	385.73
14 x 14	13-1/2 x 13-1/2	182.25	2767.92	2767.92	410.06	410.06
14 x 16	13-1/2 x 15-1/2	209.25	4189.36	3177.98	540.56	470.81
14 x 18	13-1/2 x 17-1/2	236.25	6029.30	3588.05	689.06	531.56
14 x 20	13-1/2 x 19-1/2	263.25	8341.73	3998.11	855.56	592.31

LINEAR CONVERSION TABLE

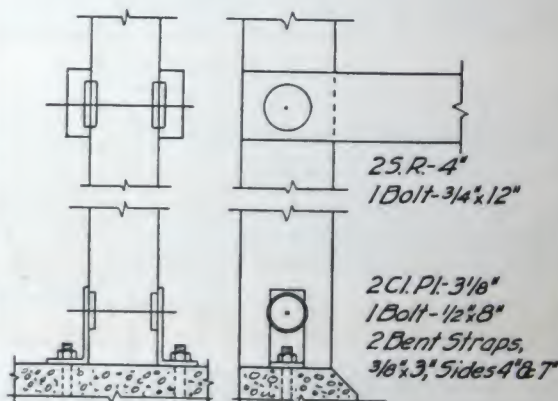
Fraction of Inch	Decimal of Inch	Decimal of Foot	Inches	Decimal of Foot
1/16	0.0625	0.0052	1	0.0833
1/8	.1250	.0104	2	.1667
3/16	.1875	.0156	3	.2500
1/4	.2500	.0208	4	.3333
5/16	0.3125	0.0260	5	0.4167
3/8	.3750	.0313	6	.5000
7/16	.4375	.0365	7	.5833
1/2	.5000	.0417	8	.6667
9/16	0.5625	0.0469	9	0.7500
5/8	.6250	.0521	10	.8333
11/16	.6875	.0573	11	.9167
3/4	.7500	.0625	12	1.0000
13/16	0.8125	0.0677		
7/8	.8750	.0729		
15/16	.9375	.0781		
1	1.0000	.0833		

LEGEND FOR TIMBER CONNECTORS, GROOVES AND DAPS

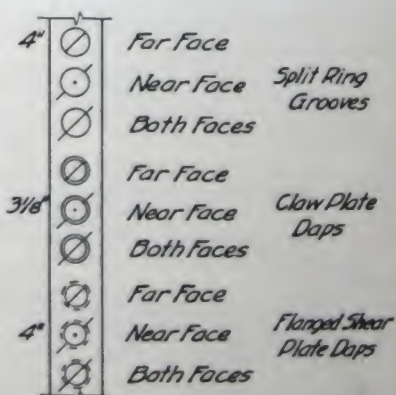
The sample legends shown below indicate the sizes and positions of connectors on structural drawings and shop details.

All types of circular connectors may be indicated on structural drawings by a circle with the type, size and number of connectors and bolts written in near the joint. Where two types of connectors occur in the same design, a double circle for indicating one type and a single circle for the other type will make it easier to determine rapidly the location of each type of connector. The square grids and clamping plates may be shown by a square drawn around the bolt hole; the number of connectors and type, also the bolt size should be written in on the drawing.

Grooves or daps for connectors on shop drawings may likewise be indicated by a circle provided only one kind is used on a drawing. If grooves and daps must both be shown, a single and double lined circle will be sufficient to differentiate them. Where three types of grooves must be cut, a solid circle within a dashed circle may be used to indicate the third type. The diameter of the groove or dap must be written on the drawing to avoid confusion unless all are the same diameter. The occurrence of the groove or dap on the near, far or both faces may be indicated by a diagonal line as shown on the accompanying sketch.



DETAILS



LEGEND FOR GROOVES AND DAPS (Shop Details)